Report of JPL ITRS Combination Center

presented by

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JTRF2014 Updates

Towards More Frequent Terrestrial Reference Frame Updates

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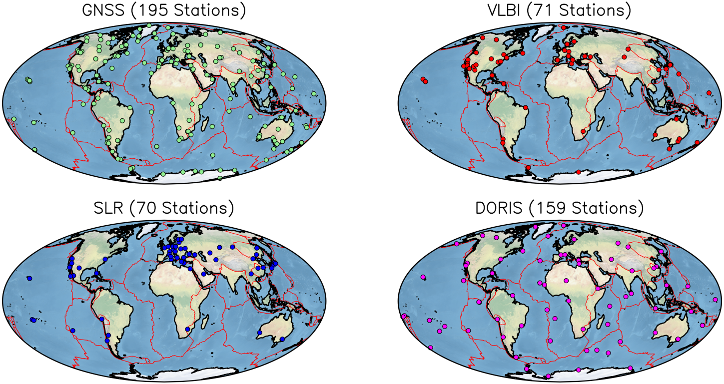
Why Would TRF Updates Be Useful?

- ITRF official products are **released at intervals of 3-to-5 years** (see *http://itrf.ensg.ign.fr/*)
- **Frame Obsolescence**, i.e. frame degradation with time [see e.g. Blewitt, 2015]
  - TRFs do not age well:
    - Quakes, equipment changes at ITRF sites introduce station position discontinuities and degrade the frame quality
    - 3-to-5 years in between ITRF releases acceptable (?) tradeoff (new releases are **burdersome** and somehow prohibitive for the analyses centers, IGS/GNSS in particular, because of the entire reprocessing of an ever-increasing dataset)
  - Frequent Frame Updates instead of frequent ex-novo (and impractical) Frame releases might alleviate obsolescence.

Why Would TRF Updates Be Useful?

- To maintain the accuracy of ITRF-like terrestrial frames by updating them as new data become available.
- To maintain the consistency of the Earth Orientation Parameters (EOPs) with the updated terrestrial frames (EOPs get assimilated as well when updating the TRF).
- To provide updates to the time series of geocentre motion (CM-CN) based on the assimilation of new data.

Global Space-Geodetic Network

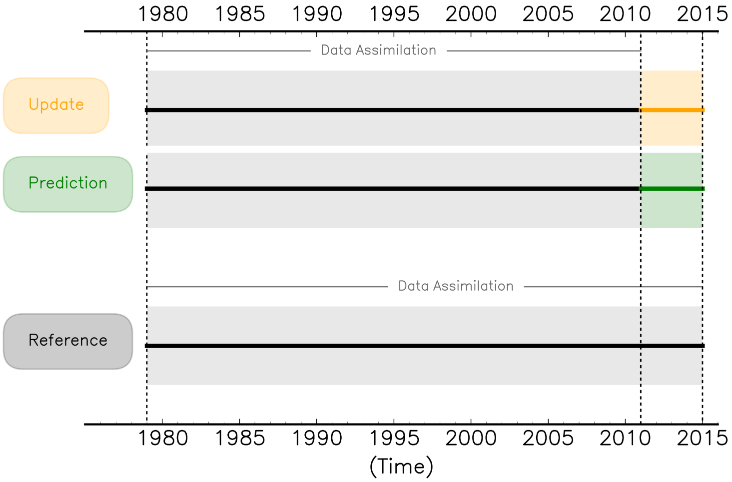


Global Space-Geodetic Networks adopted in our proof of concept
(**495** Stations with Observing History $>$ **2.5** years)

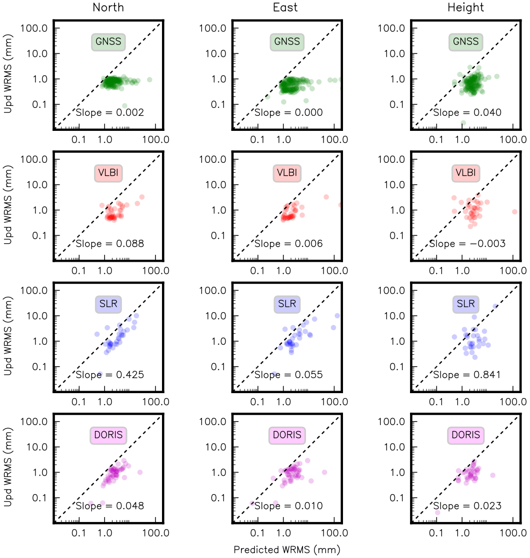
Dataset and Combination Setup

Dataset	SNX Files from IGS,IVS,ILRS,IDS for ITRF2014
Network	495 Stations
Frame Type	Time Series
Model	Trend, Annual
Process Noise	Station-Dependent Random Walk
Origin	Quasi-Instantaneous CM (SLR)
Scale	Quasi-Instantaneous SLR/VLBI
Orientation	No-Net-Rotation to ITRF2008

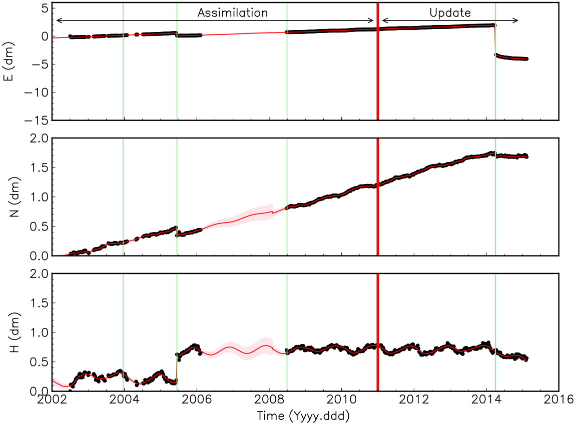
Combination Tests For our Proof of Concept



Scatterplots of the WRMS Differences (Pred/Upd - Truth)



GNSS Station at Iquique (Chile) – Updates

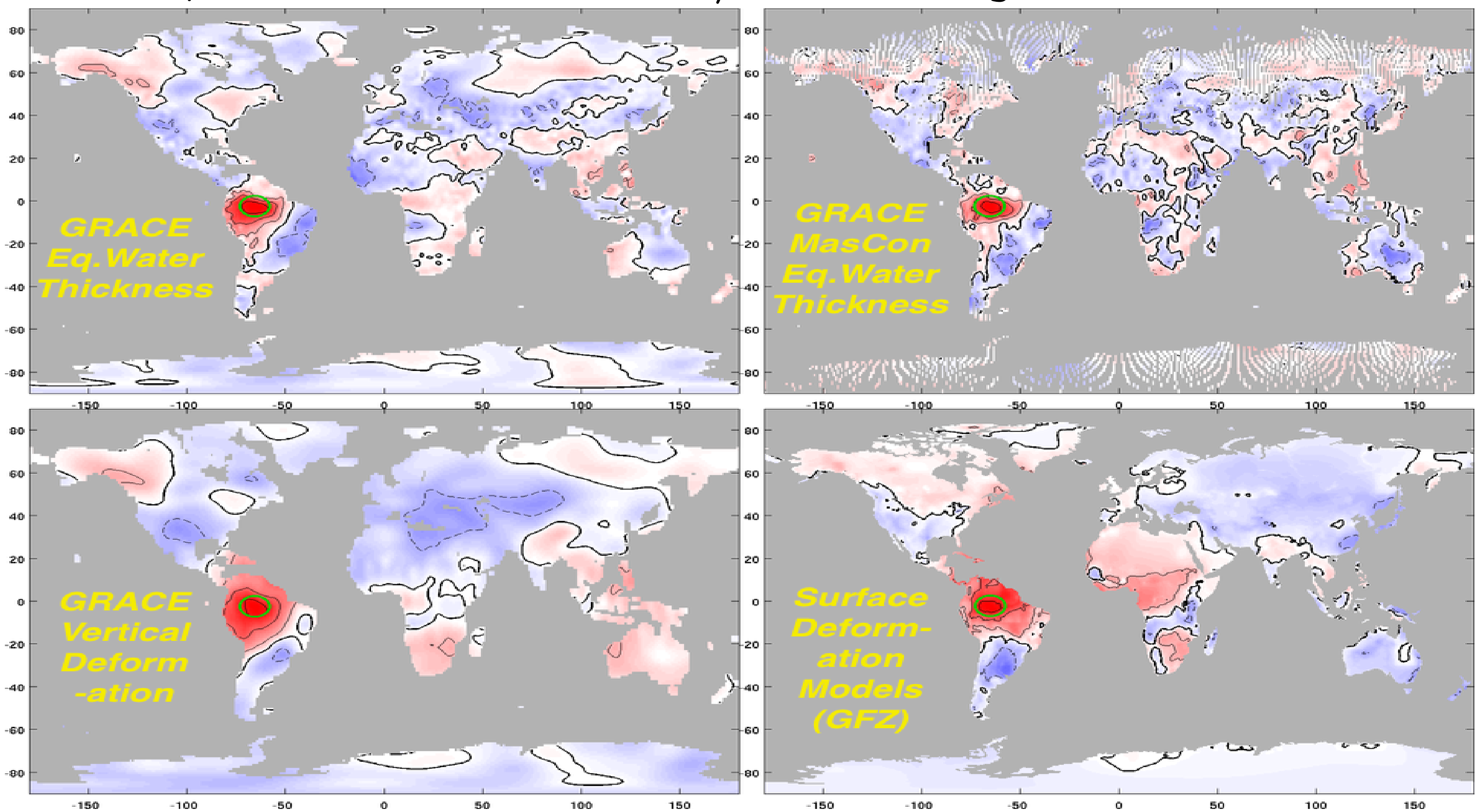


Black dots are position observations, whereas red solid lines are KALREF-derived. Solid green vertical lines mark position offsets. Light red-shaded envelopes represent $1 - \sigma$ error bars.

Correlations in Ground Deformation

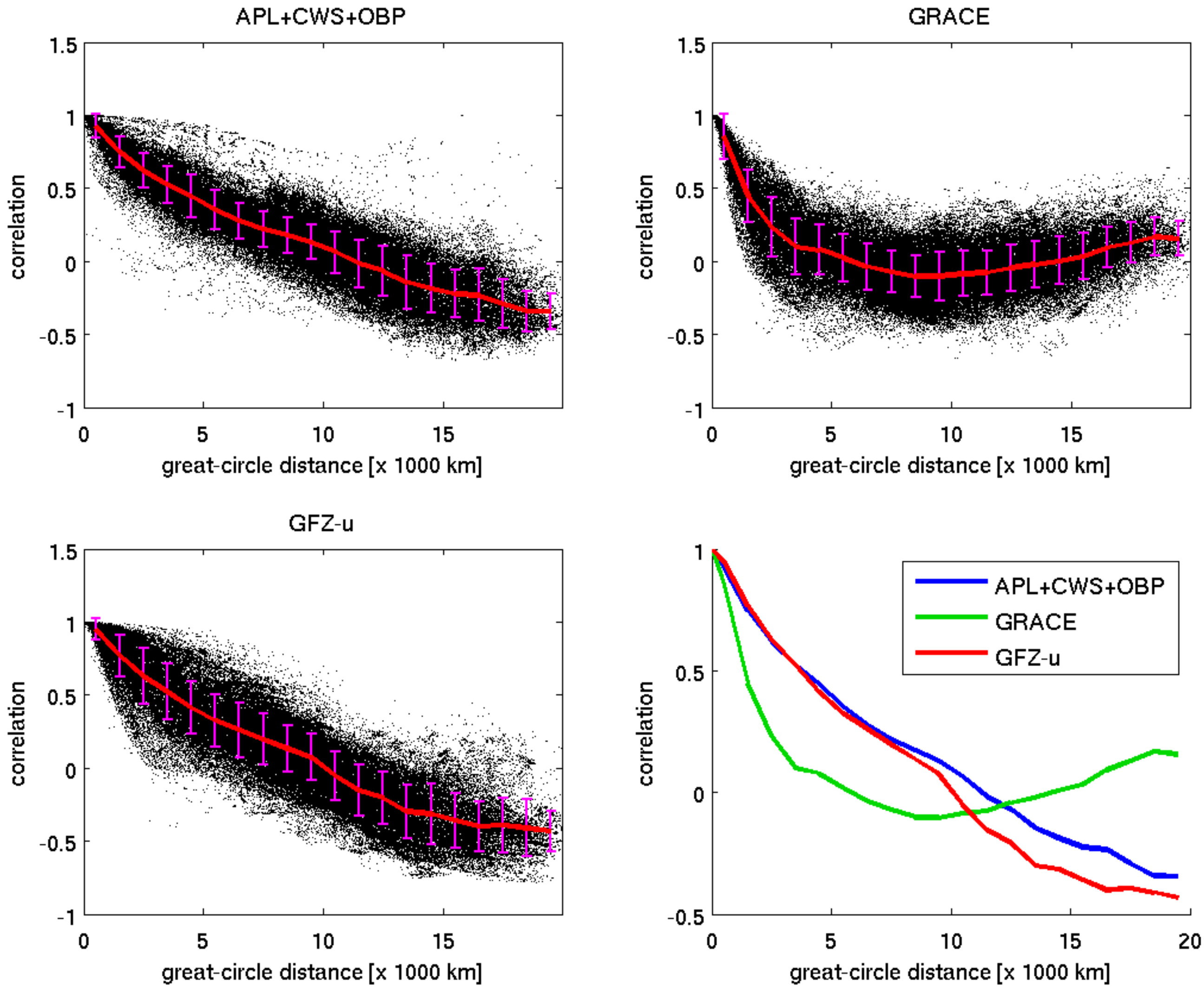
Correlation Coefficients: GRACE and other data

GRACE equivalent water with atmos/ocean loading restored:



Last panel: GFZ surface fluid loading model data (Dill and Dobslaw 2013)

⇒ Some long-distance correlations may be noisy/inconsistent.



APL+CWS+OBP
GRACE
GFZ-u
correlation
great-circle distance [x 1000 km]
APL+CWS+OBP
GRACE
GFZ-u

Joint TRF / CRF / EOP Determination

AGU Fall Meeting, New Orleans, LA, USA – December 11, 2017

A two-level approach to VLBI terrestrial and celestial reference frames using both least-squares adjustment and Kalman filter algorithms

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New concept for terrestrial reference frames

DTRF2014

- Least-squares adjustment
- Input: normal equations
- Secular frame
- Optional loading displacement time series

[Seitz et al., 2016]

JTRF2014

- Kalman filter + smoother
- Input: station coordinates + covariances
- Time series frame

[Abbondanza et al., 2017]

New concept

- Least-squares adjustment
- Normal equations
- Secular frame
- Optional Kalman filter time series based on residuals of secular frame

New concept for celestial reference frames

ICRF2

- Least-squares adjustment
- Input: normal equations
- Constant frame

[Fey et al., 2015]

Kalman filter CRF

- Kalman filter + smoother
- Input: station coordinates + covariances
- Time series frame

[Soja et al., 2017]

New concept

- Least-squares adjustment
- Normal equations
- Constant frame
- Optional Kalman filter time series based on residuals of constant frame

Realizing the new concept

1. Single-session analysis to create normal equations
2. Computation of secular frames (global solution)
   - NNT/NNR w.r.t. DTRF2014 and NNR w.r.t. ICRF2
   - Two TRF solutions: linear & linear + annual + semi-annual
3. Apply secular frames in single-session analysis to estimate station and source coordinates
   - Residuals w.r.t. secular frames
4. Feed residuals into Kalman filter and smoother to create time series consistent with secular frame
   - 6-parameter transformation to DTRF2014
   - 3-parameter rotation to ICRF2

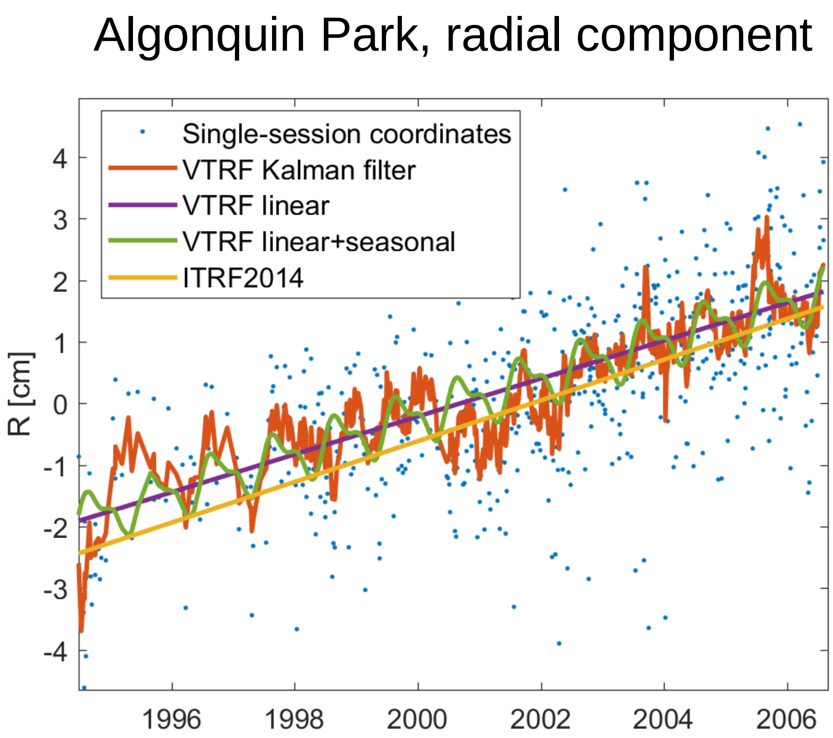
VLBI data

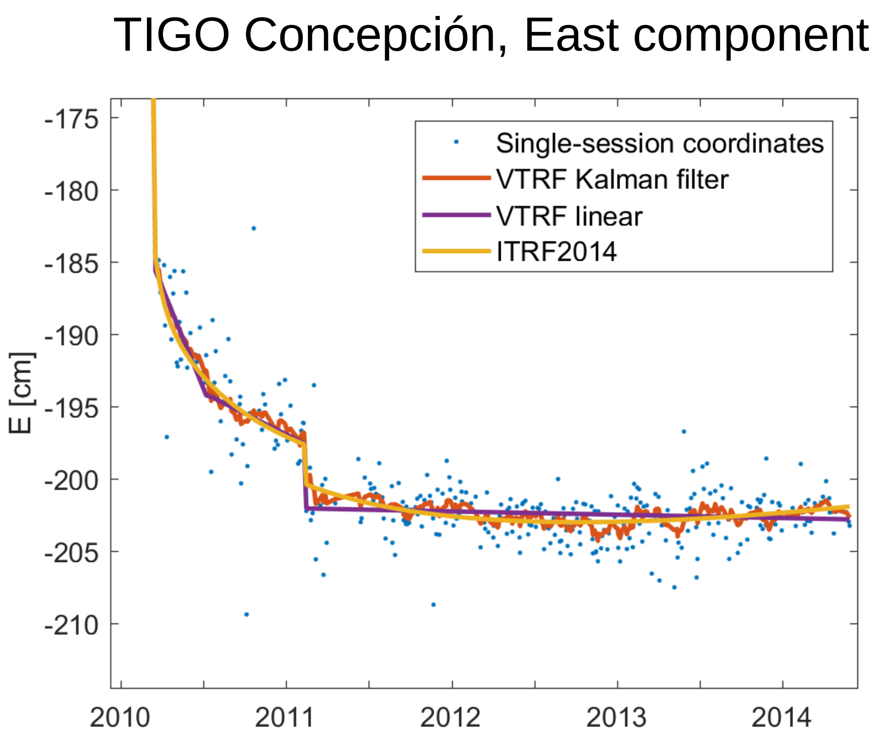
- 1980 – 2016.5
- 5446 IVS-VLBI sessions

- Secular frame
  - 136 VLBI stations (22 used for datum definition)
  - 4097 radio sources (1178 used for datum definition)
  - Seasonal signals: only estimated for datum stations

- Time series frame
  - 119 VLBI stations
  - 822 radio sources

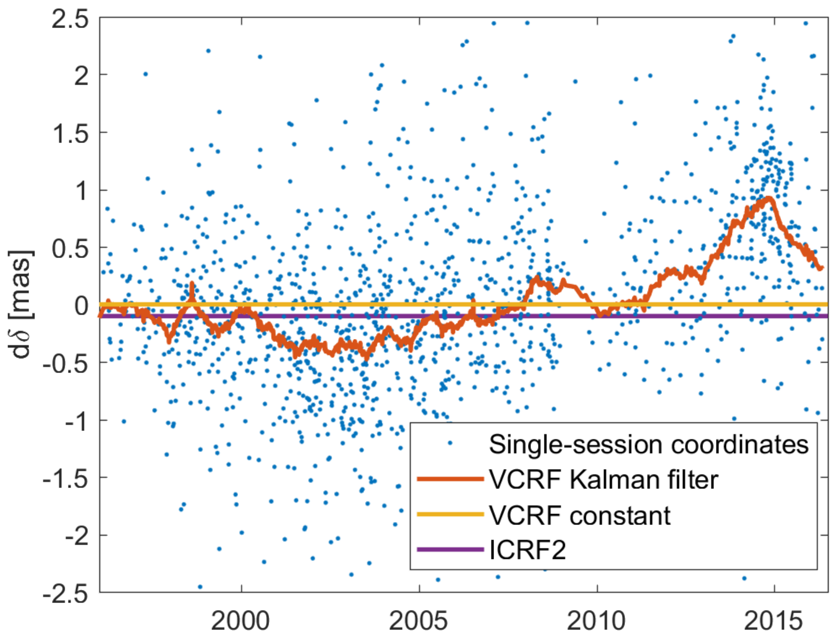
TRF solution examples





CRF solution examples

0119+115 (defining), declination



4C 39.25 (special handling), right asc.